

Development of NFIQ 2.0

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http://www.nist.gov/itl/iad/ig/development_nfiq_2.cfm

April 26, 2013 Winchester, UK



2004 - present

2004

- •Release of NFIQ 1.0
- •Novel definition of biometric quality
- performance related
- accepted by the community
- Interoperability
- •uniform interpretation
- •tuned to a class of matcher
- Open source
- Extensively examined
- •by NIST and others
- •tools for quality summarization, slap, ...

2010 workshop

- •Workshop on March 6, 2010 (IBPC 2010)
- •NFIQ 2.0 wish-list as of March 2010
- •Several options for NFIQ 2.0 were discussed
- http://biometrics.nist.gov/ cs_links/ibpc2010/ options_for_NFIQ2.0.pdf
- •The community overwhelmingly recommended a new, open source, generalized version of NFIQ to be developed in consultation and collaboration with users and industry.
- •Same technical approach, but better, bigger, faster, etc.

012 workshop

•Workshop on March 5, 2012 (IBPC 2012)

NFIQ 2.0 wish list as of March 2010 Components as of March 2012

- Community asked for:
- Actionable flags
- •providerID
- Versioning
- •Latent?



NFIQ 2.0 Community

Team Members

- ≫ NIST (US)
- > BSI (Germany)
- BKA (Germany)
- Fraunhofer IGD
- > Hochschule Darmstadt / CASED
- Securet Security Networks AG
- ≫ NFIQ 2.0 Participants
- ...and the whole biometrics community

Sponsors



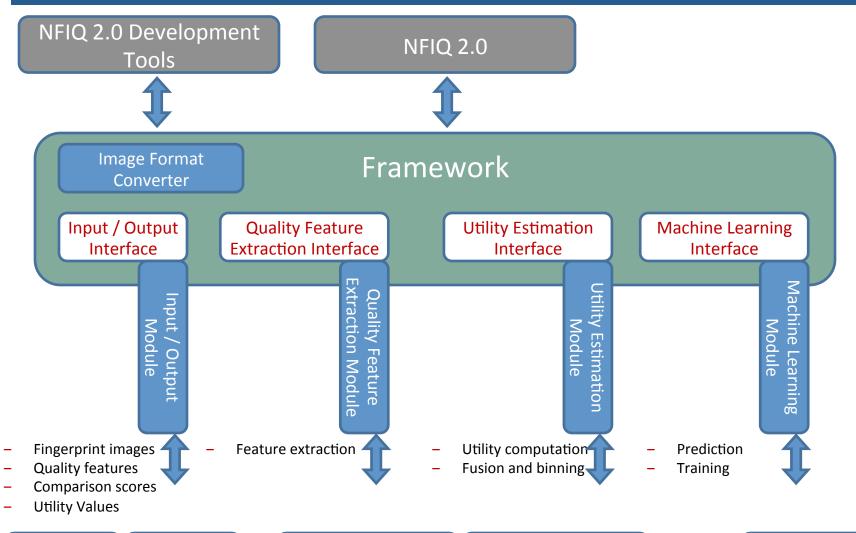


Science and Technology





Architecture of NFIQ 2.0 Framework

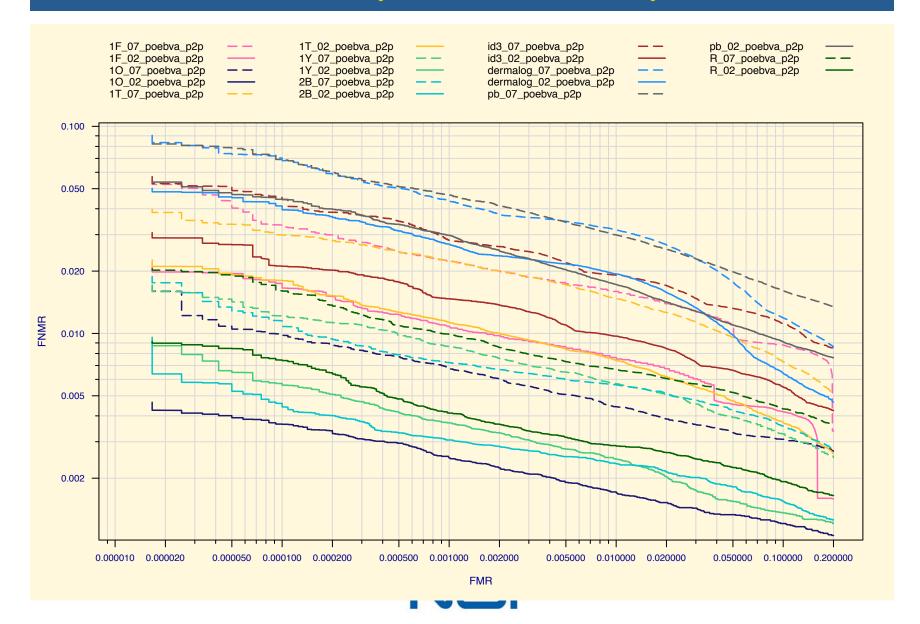






MLP

NFIQ 2.0 comparison score provider



NFIQ 2.0 features

Image/signal processing

- » Local clarity score
- » Ridge valley uniformity
- » Orientation certainty level
- » Orientation flow
- » Frequency domain analysis
- » Radial power spectrum
- » Gabor filters (several variants)

Minutiae based

- FingerjetFx
 - Open source implementation from digitalPersona
 - Digitalpersona.com/fingerjetfx
- » Total count of minutia
- » Count of minutia in region of interest
 - Various selection of ROI

Standardized features allow for plug and play of feature computation implementations that are semantically conformant to the standard (i.e., ISO/IEC 29794-4 and ISO/IEC 19794-4).

Different implementations are distinguished via providerID.



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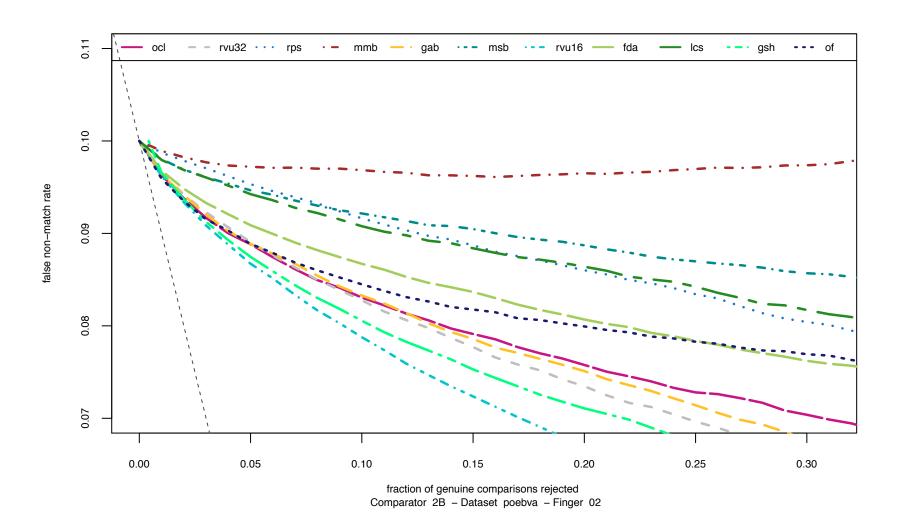
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NFIQ 2.0 features - 3





Machine Learning

Random Forest

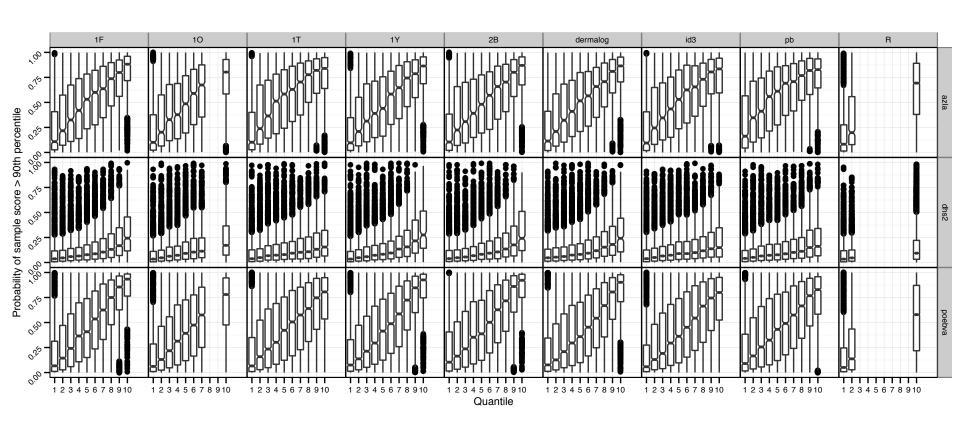
- Ensemble classifier using stochastic process
 - Use vote to determine class memberships
 - Provides class probability in predictions
- » Training
 - All features
 - 4874 samples in each of the low and high performers classes
 - 1000 trees in forest
- » Test
 - 287 895 comparison scores

Two class prediction

- » High vs. Low performers
 - 1: High performers are images that result in high genuine scores
 - $> CDF^{-1}(0.95)$
 - 0: Low performers are images that result in false reject
 - Threshold at FMR=0.0001
 - Quality score is the probability that a given image belongs to class 1.
- Map quality score to recognition rate.

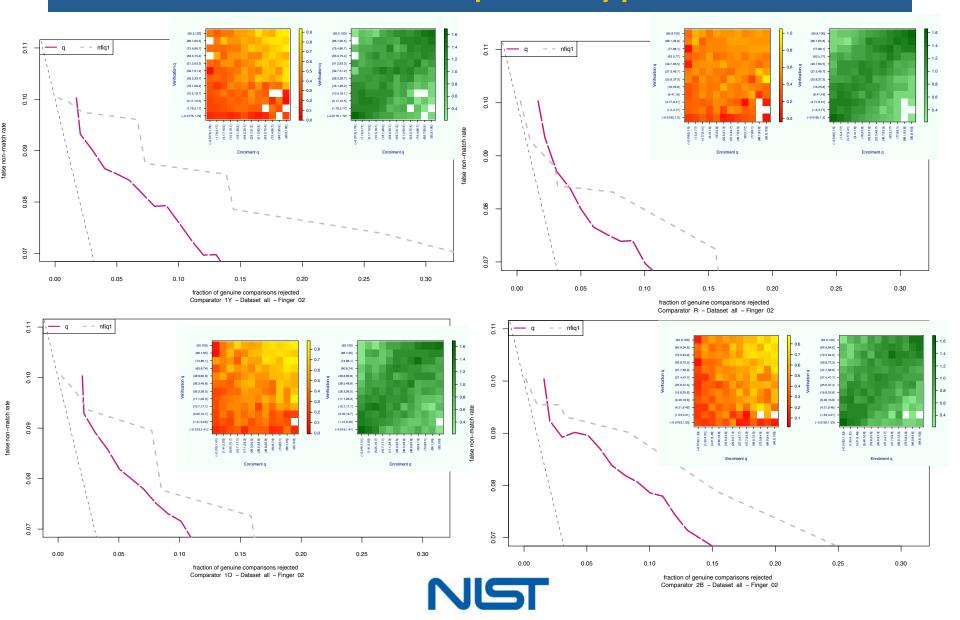


NFIQ 2.0 prototype





NFIQ 2.0 prototype



Actionable quality

Feed back to user/operator

- » Wet / dry
 - High/low pressure
- » Centeredness
 - Singularity detection
- » Incompleteness
 - Singularity detection
- » Ghost images



Questions?

- » Sensor sensitivity?
- » Algorithm sensitivity?
- » Already covered by features?
- Any addition or deletion?
 - Fingerness?
 - Alteredness?
 - correctness of phalanx?

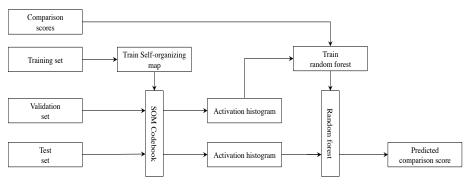




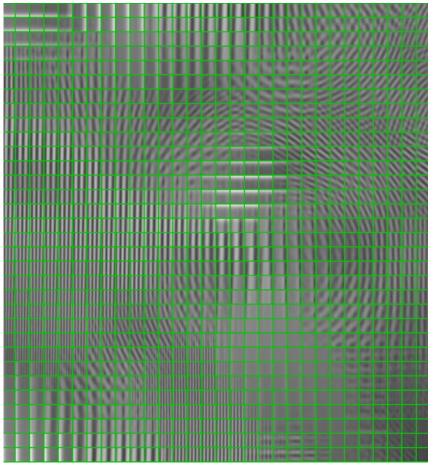
NFIQ 2.0 Lite/Mobile

Requirements

- » Low computation complexity
 - processing power
 - Processing time
- » Therefore, feature computation not feasible!
- » Look up table?



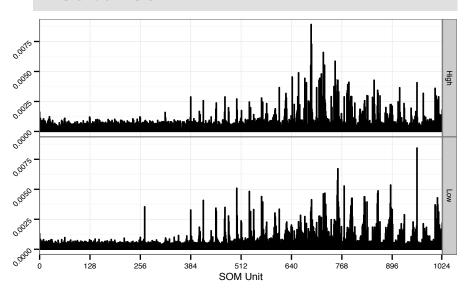
SOM code book

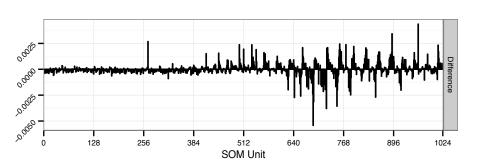




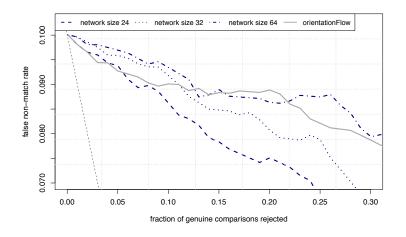
NFIQ 2.0 Lite prototype

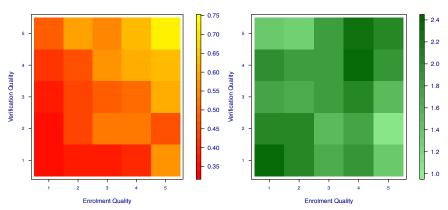
Features





performance







NFIQ 2.0 computation time

Lite

- » ~ 65 ms/image
 - PC 2.3 GHz Intel Core i7
 - 16 GB of memory.
 network size of dim = 24
 - block size of n = 24
 - With gray scale normalization
- » ~ 82 ms/image.
 - PC 2.3 GHz Intel Core i7
 - 16 GB of memory.
 - network size of dim = 24
 - block size of n = 64
- This is prior to any code optimization

NFIQ 2.0

- » ~ 19.45 msec/image
 - MacBook Air, Mid 2011
 - Processor: 1.7 GHz Intel Core i5 (dual core)
 - Memory: 4 GB 1333 MHz DDR3 (256 KB L2 cache, 3MB L3 cache)
 - Software: OS X 10.8.3 (12D78)
 - for OCL Expect about the same for other features
- » ~85 msec/image
 - Minutia based
- This is prior to any code optimization



Current Status

Completed

- Framework design
 - Modular, plug and play
- » Framework implementation
- Feature selection and prototype implementation complete
 - http://biometrics.nist.gov/ cs_links/quality/NFIQ_2/ NFIQ-2_Quality_Feature_Defin-Ver05.pdf
- » Feature evaluation complete

Underway

- Feature Implementation MATLAB to to C/C++
 - Thanks to FBI
- Exploring machine learning
 - Random forest, SVM.
- » NFIQ 2.0 Lite
 - Self organizing map
- Implementation of actionable flags for detection and mitigation of bad presentations
 - Incomplete finger (tip, etc.) + Wet / dry
 + Pressure
- Standardization of NFIQ 2.0 feature (ISO/IEC 29794-4)
 - Allows for plug-and-play of features for implementations that satisfy semantic conformance to the requirements of the ISO/IEC 29794-4 standard



NFIQ 2.0

Promises, promises

- » Improved feature
- » More level (0-100)
- » Faster, lighter
- » Actionable feedback
- » NFIQ 2.0 mobile
- » Slap
- » Better performance
- » Modular design
- » Calibration
- » Conformance testing

So far, we have achieved

- » Improved feature
- » More level (0-100)
- » Faster we hope
- » Actionable feedback
- » Towards NFIQ Mobile
- **>>** --
- » Better performance we hope
- » Plug and play



Coming up

1	Publication of NFIQ 2.0 Feature Evaluation (NIST IR)	June 2013
2	Publication of use of machine learning techniques in NFIQ 2.0 (NIST IR)	August 2013
3	Biometric quality workshop at BCC 2013 - Tampa, FL Present NFIQ 2.0 with possible demo at NIST booth	Sept 17, 1040–1200 Room 20
4	Standardization of NFIQ 2.0 features (ISO/IEC 29794-4)	2015+



NIST Biometric Quality Program Push Towards Zero Error Biometrics Strengthening Science Developing Standards Developing Tool Box **Enumerative** Advancing **Best Practice** Coordination+ metrology Guidance **Bibliography** Collaborations Failure Performance Requirements Open source Instructional + Technical **Analysis** Evaluation Specifications **Public domain** Guidance Literature Materials for Identifying the Quantitative On image Reference Reports, white Workshops, likely causes of means of properties implementatio quality score papers, publications Conferences recognition assessing affecting summarization ns of quality Grants (WVU, performance performance, assessment + Best capture relevant to error, **NYU Poly)** quantifying of quality and on capture algorithm, iris practice + biometric their effect segmentation assessment device example quality and iris and ways to algorithms images of image quality various quality mitigate them. (IREX II IQCE) in particular Research Evaluation Standard Software Report Webpage **NIST IR 7155 NIST IR 7820** ISO/IEC 29794 **NFIQ 1.0 NIST IR 7422** www.nist.gov/ BQW 2006, 07 itl/iad/ig/ **ICIP 2005** ISO/IEC 19794 IBPC 2010, 12 **PAMI 2007 NFIQ 2.0 NIST IR 8XXX** bio_quality.cf **NIST IR 7820 ICPR 2010 NIIQ 1.0** NFIQ 2010,12

Thank You.

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